

## WHAT IS CLAIMED IS:

1. A positioning apparatus comprising:
  - a movable member for transmitting driving force
  - 5 in a driving-axis direction to a stage;
  - a first electromagnet for driving said movable member in the driving-axis direction by forming a magnetic path between said movable member and said first electromagnet and generating first magnetic flux;
  - 10 and
  - a second electromagnet, which is positioned away from said first electromagnet and arranged in an overlapping direction, for driving said movable member in the driving-axis direction by forming a magnetic
  - 15 path between said movable member and said second electromagnet and generating second magnetic flux having an inverted polarity from the first magnetic flux.
- 20 2. The positioning apparatus according to claim 1, further comprising current control means for applying currents of inverted polarities having substantially a same value to a first coil and a second coil so as to generate magnetic flux of different polarities in said
- 25 first electromagnet and said second electromagnet, said first coil wound around a core constituting said first electromagnet and said second coil wound around a core

constituting said second electromagnet in a same direction as the first coil.

3. The positioning apparatus according to claim 1,  
5 wherein in a case where currents of a uniform polarity having substantially a same value are applied to the first coil and the second coil, a coil winding direction of the first coil wound around the core constituting said first electromagnet is opposite to a  
10 coil winding direction of the second coil wound around the core constituting said second electromagnet.

4. The positioning apparatus according to claim 1,  
wherein said movable member comprises:  
15 a movable core portion configured with a magnetic material, which forms magnetic paths respectively between said first electromagnet and said movable core portion, and said second electromagnet and said movable core portion; and  
20 a supporting member configured with a nonmagnetic material, which supports said movable core portion.

5. The positioning apparatus according to claim 2,  
further comprising a third electromagnet, which is  
25 positioned away from said second electromagnet and arranged in the overlapping direction of said second electromagnet, for driving said movable member in the

driving-axis direction by forming a magnetic path  
between said movable member and said third  
electromagnet and generating magnetic flux having the  
same polarity as that of the magnetic flux of said  
5 first electromagnet.

6. The positioning apparatus according to claim 5,  
wherein said current control means applies currents to  
respective coils of said first electromagnet, said  
10 second electromagnet and said third electromagnet at a  
ratio of 1:2:1.

7. The positioning apparatus according to claim 3,  
further comprising a third electromagnet, which is  
15 positioned away from said second electromagnet and  
arranged in the overlapping direction of said second  
electromagnet, for driving said movable member in the  
driving-axis direction by forming a magnetic path  
between said movable member and said third  
20 electromagnet and generating magnetic flux having the  
same polarity as that of the magnetic flux of said  
first electromagnet.

8. The positioning apparatus according to claim 7,  
25 further comprising current control means for applying  
currents to respective coils of said first  
electromagnet, said second electromagnet and said third

electromagnet at a ratio of 1:2:1.

9. The positioning apparatus according to claim 1,  
comprising a plurality of electromagnet units, having  
5 said first electromagnet and said second electromagnet,  
for driving the stage in X-axis, Y-axis and Z-axis  
directions and a rotational direction around respective  
axes.

10 10. The positioning apparatus according to claim 9,  
further comprising a carriage stage for carrying said  
apparatus on a XY plane.

11. A charged-particle-beam exposure apparatus  
15 comprising:

a charged-particle source for irradiating a  
charged-particle beam;

a first electron optical system, having a  
plurality of electron lenses, for forming a plurality  
20 of intermediate images of the charged-particle source  
by the plurality of electron lenses;

a second electron optical system for projecting  
the plurality of intermediate images, formed by said  
first electron optical system, on a substrate; and

25 a positioning apparatus, holding the substrate,  
for driving a stage to a predetermined position to  
perform positioning of the stage,

wherein said positioning apparatus comprises:

a movable member for transmitting driving force  
in a driving-axis direction to a stage;

a first electromagnet for driving said movable  
5 member in the driving-axis direction by forming a  
magnetic path between said movable member and said  
first electromagnet and generating first magnetic flux;  
and

a second electromagnet, which is positioned away  
10 from said first electromagnet and arranged in an  
overlapping direction, for driving said movable member  
in the driving-axis direction by forming a magnetic  
path between said movable member and said second  
electromagnet and generating second magnetic flux  
15 having an inverted polarity from the first magnetic  
flux.

12. A device manufacturing method comprising:

a step of installing a plurality of semiconductor  
20 manufacturing apparatuses, including a charged-  
particle-beam exposure apparatus, in a factory; and

a step of manufacturing a semiconductor device by  
the plurality of semiconductor manufacturing  
apparatuses,

25 wherein the charged-particle-beam exposure  
apparatus comprises:

a charged-particle source for irradiating a

charged-particle beam;

a first electron optical system, having a plurality of electron lenses, for forming a plurality of intermediate images of the charged-particle source  
5 by the plurality of electron lenses;

a second electron optical system for projecting the plurality of intermediate images, formed by said first electron optical system, on a substrate; and

a positioning apparatus, holding the substrate,  
10 for driving a stage to a predetermined position to perform positioning of the stage,

wherein said positioning apparatus comprises:

a movable member for transmitting driving force in a driving-axis direction to a stage;

15 a first electromagnet for driving said movable member in the driving-axis direction by forming a magnetic path between said movable member and said first electromagnet and generating first magnetic flux; and

20 a second electromagnet, which is positioned away from said first electromagnet and arranged in an overlapping direction, for driving said movable member in the driving-axis direction by forming a magnetic path between said movable member and said second  
25 electromagnet and generating second magnetic flux having an inverted polarity from the first magnetic flux.